MULTILOGUE: PERSPECTIVES ON COMPUTATIONAL THINKING AND ITS UTILITY FOR TRANSFORMATIVE EDUCATION[1]

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The following text is a collaborative multilogue between the Centre for Critical and Cultural Theory at the Department of Anglophone Literatures and Cultures (Charles University) and the Department of Education, Human Sciences and Intercultural Communication (University of Siena). It focuses on the affordances and dispositions of computational thinking within education and unpacks the recent calls for critical reflection within the field of the digital humanities. The initial impulse for assembling this collaborative reflection came from the European Liberal Arts Network program intended to foster inter-institutional exchange and collaboration.

Vít Bohal: Computational thinking has been a central issue in the digital humanities scholarship for more than a decade and its impact on pedagogy has increasingly become a point of interest.[2] David Berry's and Anders Fagerjord's *Digital Humanities* (2017) for example introduces the notion of the "Digital Humanities Stack" which regards computational thinking as one of the two

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[2] Jeannette M. Wing, "Computational Thinking and Thinking about Computers," *Philosophical Transactions of the Royal Society*, 366 (2008): 3717; Jeannette M. Wing, "Computational Thinking Benefits Society," *Social Issues in Computing* (10 January 2014), http://socialissues.cs.toronto.edu/index.html%3Fp=279.html, accessed 19 December 2019. See also David M. Berry, "The Computational Turn: Thinking about the Digital Humanities," *Culture Machine,* 12 (2011): 1-22.

fundamental components of "Encoding and Education." In their chapter entitled "On the Way to Computational Thinking," the two authors chart the genealogy of the concept, and further speculate on its further role in the formation of the digital humanities and pedagogy. They define computational thinking as

> the ability to reflect routinely on where the computer may be applied to humanities work in order to automate a process or a collection of processes. This ability to recast the humanities work within a workflow that can be broken up into discrete elements subject to an automation is a core constituent of the ability to create and manipulate humanities data in the digital humanities.[3]

The authors make clear that they do not regard computational thinking as just the know-how of linking up systems in the concrete, but also the ability to design systems in the abstract and have one's own thinking be recursively defined by those systems, detailing for example the way in which language and cognition are structured by thinking through the very metaphors of code, such as "objects, classes, and instances."[4]

One of the most cited framings of computational thinking is that of Jeanette M. Wing who, building on the work of Aho and Ullman, defines computational thinking as an "automation of our abstractions"[5] which functions within the overlapping field between mathematical, scientific, and engineering thinking. Wing thus also defines computational thinking not only as a form of practical knowledge, but rather as a type of computer-oriented cognitive syntax, a system of abstraction which has the capability to change a human's perception of the world and the affordances which it provides.

It is interesting to focus on the criticisms levelled at the often highly techno-optimist and technocratic approach to computational thinking. In his latest book *New Dark Age* (2018), James Bridle for example fears the implications of thinking through machines, and regards computational thinking as a "chasm"[6] which leads to a type of general solutionist mind-set. Believing that we lose more than we gain in indiscriminately hopping on the bandwagon of computational modes of thought, he writes that

3 David M. Berry and Anders Fagerjord, *Digital Humanities: Knowledge and Critique in a Digital Age* (Cambridge: Polity, 2017) n.p.

4 Berry and Fagerjord, n.p.

5 Wing, "Computational Thinking and Thinking about Computers," 3718.

6 James Bridle, *The New Dark Age* (London: Verso, 2019) 10.

> Computational thinking is an extension of what others have called solutionism: the belief that any given problem can be solved by the application of computation. Whatever the practical or social problem we face, there is an app for it. […] computational thinking supposed – often at an unconscious level – that the world really is like the solutionists propose. It internalises solutionism to the degree that it is impossible to think and articulate the world in terms which are not computable.[7]

Bridle regards this as the crux of our contemporary socio-political crisis – the fact that people living in the digital milieu have lost contact with what is real and what is virtual (most succinctly encapsulated in the concept of "automation bias"). He goes on to critique the fallacy of the seeming solutionist overlap between the reality and its virtual model, between the map and the territory. Bridle is merely one among many thinkers who level similar accusations towards Wing's latently entrepreneurial and techno-optimist vision for how computational thinking can and should be instrumentalised.[8]

Considering that both Bridle and Berry and Fagerjord understand the need for a critical approach to the field of digital humanities, the question of how computational thinking dovetails with this critical turn is central. A cogent critique of computational thinking is especially central for didactics, as it has been the nexus of the debate since its very inception[9] and is the field where the digital humanities have the greatest impact and through which they are further promulgated. Computational thinking and its role in the formation of the future through educational practices is thus a central issue which any critical reappraisal of its modus operandi ought to address.

Alessandra Romano: I would like to offer new insights by adopting the conceptual framework of the transformative learning theory,[10] of critical reflection study[11] and of a post-modern perspective on computation in the context of

7 Bridle 4.

8 Steve Easterbrook, "From Computational Thinking to Systems Thinking: A Conceptual Toolkit for Sustainability Computing," *Proceedings of the 2014 Conference ICT for Sustainability* (Paris: Atlantis Press, 2014) 236-38. Laura Pappano, "Learning to Think Like a Computer," *The New York Times*, 4 April 2017, www.nytimes.com/2017/04/04/education/edlife/teaching-students-computer-code.html, accessed 19 December 2019.

9 Jeannette M. Wing, "Computational Thinking," *Communications of the ACM* 49.3 (March 2006): 33-35.

10 Jack Mezirow, *Apprendimento e trasformazione* (Milano: Raffaello Cortina Editore, 2003).

11 Donald Schön, *Il Professionista Riflessivo: Per una Nuova Epistemologia della Pratica Professionale* (Bari: Edizioni Dedalo, 1993).

learning.[12] My position is in the wide-range of theories and contributions on adult education, teaching and learning methods. Some questions came up in my mind: How does the metaphor of computation represent a way of setting problems for the teacher and learner?

Most teachers and education researchers have the intuition that computational thinking is a skill rather than a particular set of applicable knowledge.[13] It's a skill that allows one to start from a problem or a confused situation, and to set a problem-solving chain through concepts such as representation, divide-and-conquer, abstraction, information hiding, verification, and logical reasoning. This is not just a narrow process: feedback, unexpected outcomes, and unresolved issues are stimuli to re-think back to the programming/setting.

In this sense, how computational thinking is a metaphor for introducing problem-based and problem-setting thinking? How could problem-based learning facilitate a way to translating computational thinking into didactic practices?

Furthermore, I would like to recall also posthumanist epistemologies. Post-modern/posthumanist epistemologies decentre the human subject, linking the social and the natural, the mind and body and the cognitive and the affective.[14] This post-epistemology enables to go beyond the problematic dualisms of action/structure, human/non-human, mind/body, machine/mind, in order to see reason not as an innate mental faculty, but as a phenomenon of practice, and to question individual actions and their status as building blocks of the social.[15] Hence thinking and learning processes, the hand and the head, the body and the machine, should be viewed as connection-in-action and in interaction.

Louis Armand: The relationship of so-called computational thinking to pedagogy raises a number of questions, of a similar kind to those posed by Greg Ulmer's *Applied Grammatology* (1985), which is that of educational 'method' and the reconstitution of the logos of a 'positive science' of communication and control.

12 S. Gherardi, E. Houtbeckers, A. Jalonen, G. Kallio, S. Katila, P.-M. Laine, "A Collective Dialogic Inquiry into Post-Qualitative Methodologies," workshop at the Nordic Sociological Association (NSA) Conference, Helsinki, 11-13 August 2016.

13 P.J. Denning, "Remaining Trouble Spots with Computational Thinking," *Communications of the Association for Computing Machinery*, 60.6 (2017): 33-39.

14 Gherardi, et al. n.p.

15 T.R. Schatzki, "Introduction. Practice Theory," *The Practice Turn in Contemporary Theory*, ed. T.R. Schatzki, Karin Knorr-Cetina and Eike von Savigny (London and New York: Routledge, 2001) 1-14.

This problematic has found recent echoes in Bratton's conception of the "Stack"[16] as an architectural system of computational thought in which stochastic processes of cybernetic evolution are formalised and brought under the logistical control of 'intelligent' megastructures. That these logistical ecologies are conceived of as autonomous agencies poses an additional question of how such an over-scaled evolutionary programme can be separately defined from that of the corporate-state apparatus?

The weight of Bratton's argument tends towards both a consequentialist 'evolutionary necessity' and a social pragmatics, envisaging a pedagogy designed to produce (human) operators whose function would be both parasitic and catalytic. These questions then become: How do tendencies of machinic learning function to entrain the social in an ongoing subjectivisation to systems of corporate-state control, under the deceptive rubric of "autonomous" (therefore somehow emancipative) AI? Against such an entrainment, what resources can be extracted from computational thinking (such as GANs [Generative Adversarial Networks]) for a radical pedagogy capable of deploying strategic and tactical means of subverting a social cybernetics of control, and of exposing and neutralizing systems of crypto-"encoding" (from data aggregation to social credit)?

Alessandra Romano: The question then seems to be how to develop a radical pedagogical approach that nurtures emancipatory learning via tactical means. How and under what conditions is it possible to promote the subversion of the cybernetics of social control? As faculty and adult educators, our interest is in searching and finding methodological paths capable of promoting awareness and reflective thinking upon virtually-mediated constraints. We refer particularly to the theoretical framework of the reflective and transformative education as applied to social and virtual contexts of life. Our choice implies an epistemological lens on how learners develop capabilities and competences to validate the way humans and non-humans are interconnected in order to reach a subversive counter-interpretation of the power between the human and the computer.

We suggest interpreting computational thinking as a problem-based approach and to avoid extremist and radicalised positions against technology-based solutions working within a material network composed of objects and subjects. In this sense, computational thinking is much more than a metaphor for understanding and defining the act of thinking and of mental processes through the mediation of a computer. This opens up to an educational stance that considers

16 Benjamin Bratton, *The Stack* (Cambridge, MA: MIT Press, 2015).

learning processes as problem-set/problem-solve procedures aimed at promoting emancipatory positions and that refuse reductionism.

Vít Bohal: The question then seems to be in what manner computational thinking 'entrains' or co-opts passive reproduction on the part of the learner, and in what manner it can be a method of personal, as well as community-based, or even society-wide, emancipation. In what way does the teaching of computational thinking create complicity on the part of the learners, and in what manner can it be a method for emancipatory and potentially subversive, praxis?

One thing Alessandra Romano has written here, is that computational thinking is "a set of pedagogical skills and an educational stance that considers learning processes as problem-set/problem-solve procedures [...]." In *The New Dark Age*, James Bridle speaks exactly against this type of "solutionist" mindset.[17] His stance is extreme on the spectrum insofar as he regards the very conception of 'solving' the current problems of the digital age with more computational thinking as completely misplaced and implicitly suspect. An analogous stance can be found in the critical theorist Arran Crawford's statement that "[t]he political temptation [...] to seek political solutions to the catastrophe of politics" is inherently misplaced insofar as the situation of a seeming political *cul de sac* will not be solved with more politics.[18] Is the "temptation to seek computational solutions to the catastrophe of the computational era" also an example of misplaced hope? Are the skill sets which support computational thinking inherently perverted by twenty-first century corporate-state apparatuses?

I do not think so. The "problem-set/problem-solve" focus of computational thinking can just as easily be used for personal and social emancipation if approached with a properly critical (i.e., non-reductionist) frame of mind. As an example, the skill of cryptography does not necessarily have to be employed in the service of a corporate-state apparatus, but can just as easily be employed on the level of micro-politics, such as in using encrypted email (Protonmail, Riseup), alternate systems of exchange and contracting (blockchain, smart contracts), or creating alternate social networks which are not complicit with the Big Data trading of Facebook or Google (Diaspora).

The question of solutionism always integrally asks about alignment with shared goals: in whose service is the problem-solving potential of computational thinking employed often remains a largely open question. In many cases, knowledge of computational thinking can in fact foster the ability to decouple

17 Bridle 4.

18 Arran Crawford, "On Letting Go," *Šum: Revija za kritiko sodobne umjetnosti*, 9 (2018): 1178.

from ethically suspect service providers and generate alternative projects of community building, cultural production and economic exchange.[19]

Mario Giampaolo: Reading the insights that Alessandra Romano, Vít Bohal and Louis Armand expressed, my thoughts in relation to computational thinking go to the coding activity. It is in the writing of languages intended for a machine that computational thinking can find space for its development. Computers are ideal performers but they are not intelligent: this is why the instructions a machine has to execute require a higher degree of formality and rigour than communication between humans. Programming makes the concepts of computational thinking concrete and becomes a learning tool.

Coding software as learning tools can be divided in two categories: text programming systems and visual programming systems: in the first the instructions must be written in sequence using a text editor; in visual systems, instead, the single instructions are represented by objects that can be dragged and combined into a work area. My aim in this discussion is to focus on the second typology of systems that offer a WYSIWYG interface for coding (WYSIWYG is the acronym of "what you see is what you get"). These interfaces make simple and learnable the competences that before could be developed only after long training (like in the case of the coding competences). For example, Scratch, developed in 2007 by the Lifelong Kindergarten group of the M.I.T. Boston MediaLab led by Professor Mitchel Resnick, is a software in which users can program using sequences of blocks to give instructions to characters on the screen or to robots.

Visual systems of coding are often preferred by teachers and educators because block programming allows to focus on the process, not taking into consideration the correctness of the language: the blocks are already syntactically correct and it is possible to concentrate on reasoning.

Learning to code and consequently developing computational thinking helps to acquire the awareness that it is possible to interact with IT technical tools that surround us not only passively, simply using them, but also in an active manner, that is through programming them directly. And this is, in my opinion, the real purpose that makes computational thought something necessary for everybody. To be able to interact more and more actively with the reality that surrounds us, with environments made of objects that can communicate with each other and with us, we must learn to program. Let us think of Google's "routines" or Amazon's

[19] Gene Youngblood, "Secession from the Broadcast: The Internet and the Crisis of Social Control," *Millennium Film Journal*, 58.1 (2013): 174-89.

"skills" that allow us to program environments in a simple way, using our voice and starting from a simple cause and effect formula: the IFTTT "if this then that."

Blocks or the IFTTT formula make simple to code our life: stories or videogames on a computer, intelligent objects, or robots. Things that we will find more and more in our homes and in our workplaces. This is the objective teachers and educators have to pursue in facilitating computational thinking among learners, and today more than ever this is within everyone's reach.

Louis Armand: The challenge of radical pedagogy is to develop a comprehensive and generative set of tactics and strategies for both a 'critique of reason' and a 'critique of unreason.' The working principle of what you see is what you get equally applies in this domain, both as a naked denominator (what you see is in fact what you get, even if it arrives in an inverted form) and as the seduction of a hermeneutics of 'seeing' that presents itself as neutral (outside of play): that there is a relationship between an objectifiable methodology of 'seeing' and the receipt of some *quid pro quo* on that basis (e.g., knowledge as pure [techno-cybernetic] exchange). This instrumental relationship between a certain kind of seeing and a corresponding kind of getting can and has been extended to all areas of strategic computation, in which the terms of engagement (the epistemological scene, so to speak) are pre-comprehended or predetermined (including, e.g., the "observer paradox"). Such operations, however, no matter how regressive or convoluted or relativistic, have conventionally been premised upon an underlying Reason.

The concept of unreason, or of irrationality, has not escaped this subsumption into the discourse of Reason, having been constrained, taxonomised, ordered and disciplined (in effect, rehabilitated, re-educated and re-programmed) so as to function productively within a social hermeneutics: from the institutionalisation of psychiatry to the exploitation of irrationalism and mass hysteria in propaganda, public relations, advertising, etc. Subject to the instrumental gaze of Reason, the irrational has thus become yet another tool in the mode of what you see is what you get. This tendency immediately reveals itself as one of totalisation, so that anything that falls within the field of this (panoptical) gaze – including any form of subversion, critique or counter-knowledge – must be subsumed into it and made subject to its authority or authorisation.[20]

The question, then, is not simply how such a decisively ideological formation (ramified by a general algorithmics) might be resisted within a pedagogical

[20] Michel Foucault, *Surveiller et punir: Naissance de la prison* (Paris: Gallimard, 1975).

framework – in order to permit 'free thought' or the 'freedom' of an 'experimental knowledge' that is not resigned to staying within bounds; rather the question is, what occurs in our understanding of this totalising movement when unreason can no longer be confidently assumed to be the mere object of Reason, but has itself become its dominant characteristic? In other words, when the 'logic' of such a subjection is seen to be (consequence of a deconstruction of the very paradigm of seeing) in the service of the 'irrational.' This would appear to be our current political situation, in which appeals to Reason have only exacerbated the problem because they have remained blind to this system's subversive rationale. This is the realm of Goya's *Slumber of Reason*, in which Reason engenders monsters ("El sueño de la razón produce monstruos"): not because Reason has been put to sleep, but – as Bataille writes – because a certain delirium has assumed the form of Reason.[21]

In light of the compact between a certain Reason and advances in computational thinking, pedagogy needs to be "rethought," not as a system of instruction, but as a critique of such systems (and the deep impact of their mode of pre-cognition and predetermination of the 'learning process' itself). This requires an understanding of how such (adversarial) systems themselves learn (in particular, how they aggregate data from other pedagogies) and how they are able to subject the very idea of learning to a regime of (irrational) control – in a manner not dissimilar to that of the Freudian super-ego – upon which it is made to be dependent. In this sense, the present techno-cybernetic framework for a 'new' pedagogy marks a return to fundamental questions of cybernetics itself, in the investigation of control and communication in the human machine, and within the technosphere at large: an investigation concerned with relations of complexity, indeterminacy, perturbation and the classification, ultimately, of what would constitute a 'rational' system. In this sense, too, it must contend with a residual Humanism concealed – however counter-intuitively – in such an undertaking.

In 1970, Paulo Freire identified this as a fundamental problem for theorising pedagogy, not because of some ineffable 'dehumanising' technological threat,

[21] See Jacques Derrida, "From Restricted to General Economy," *Writing and Difference*, trans. Alan Bass (London: Routledge, 1978) 251. In his *Zur Kritik der Hegelschen Rechtsphilosophie* (1843), Marx likewise describes Hegel's logic as "logical mysticism," echoing Feuerbach's phrase "mystique of reason." Cf. Karl Marx, *Early Writings* (London: Penguin, 1975) 61; Ludwig Feuerbach, *Über Philosophie und Christenthum in Beziehung auf den der Hegel'schen Philosophie gemachten Vorwurf der Unchristlichkeit* (Mannheim: Hoff und Heuser, 1839).

but because the question of technology had at last brought into view the ambivalence of the category of "humanity" (and, by implication, of Reason itself). In *Pedagogy of the Oppressed* Freire writes:

> While the problem of humanisation has always, from an axiological point of view, been humankind's central problem, it now takes on the character of an inescapable concern. Concern for humanisation leads at once to the recognition of dehumanisation, not only as an ontological possibility but as an historical reality. And as an individual perceives the extent of dehumanisation, he or she may ask if humanisation is a viable possibility. Within history, in concrete, objective contexts, both humanisation and dehumanisation are possibilities for a person as an uncompleted being conscious of their incompletion.[22]

Yet where Freire saw "dehumanisation" as a distortion, it is essential here to resist turning away from the task of examining the full implications of this ambivalence, not only for the status of the human or for an ongoing critique of Humanism – necessary as this may be – but for a radical reformulation of the pedagogical relation upon which these ideas (the human and Humanism) are ultimately dependent. Ostensibly this requires a return to the question of the subject and of intersubjectivity as articulated in the work of Lacan, not as a psychoanalysis of the pedagogical scene, but as a critical rethinking of the concept of alienation (and of technologisation) originating in Marx. In the Lacanian "mirror stage" – itself a template of the Generative Adversarial Network – alienation is not a distortion of subjectivity; it is constitutive of it. The subject does not become technologised, by virtue of its industrial-historical situation; it is technological in the very core of its being.

This requires a certain vigilance with regard to what continues, today, to be dichotomised in the relation of the so-called "human" to so-called "technology"; of "human" intelligence to "artificial" intelligence; of "human" pedagogy to "machine" learning, etc. Acceding to this re-inscription of a false binary logic is not a trivial matter, but nor is it merely a theoretical formalism: what it conceals is not a distortion of a true relation, but an entire hegemonic system of subjectivisation. Insofar as pedagogy concerns the status of an "uncompleted being conscious of their incompletion," it becomes necessary for pedagogy to

[22] Paulo Freire, *Pedagogy of the Oppressed*, trans. Myra Bergman Ramos (London: Continuum, 2000) 43.

perceive its own (necessary/strategic) incompletion within the status of a consciousness as such.

Alessandra Romano: The multilogue follows a variety of discursive trajectories that I would like to summarise here:

1) First of all, the fascination of an extremely radical emancipatory pedagogy, able to intercept the hidden power of cybernetic deception in the seduction of "what you see is what you get";

2) The effort to practice a radical post-human technological epistemology, that implies to rethink the role of agents and individuals; e.g., subjects, objects, virtual data, programming, instructions etc.;

3) foregrounds the importance of a radical critique of the questions of cybernetics itself, as Dr. Armand says, in the investigation of control and communication in human machine practices;

4) sheds new light on the nature of knowledge and discourse in the technosphere;

5) reaffirms the centrality of interests and of the constructs of power and positionality in human and non-human relationships.[23]

While transformative learning theory is originally interested in meaning perspectives' construction and analysis through validity testing and reflection on consequences of action, the post-epistemological turn, in deconstructing Freirean processes of dehumanisation, assumes human, humanism and post-human as inter-dependent units of analysis.

We may say that the transformative learning theories, as conceptualised by Mezirow,[24] Marsick and Watkins,[25] Taylor,[26] Lundgren,[27] privilege the meaning constructed by actors, from which derive meaningful systems of actions. The post-human turn locates the source of significant patterns in how virtual and

[23] Davide Nicolini, *Practice Theory, Work, and Organisation: An Introduction* (Oxford: Oxford University Press, 2012).

[24] Jack Mezirow, Edward W. Taylor, and Associates, *Transformative Learning in Practice: Insights from Community, Workplace, and Higher Education* (San Francisco, CA: Jossey-Bass, 2009).

[25] Victoria J. Marsick, Karen E. Watkins, Ellen Scully-Russ and Aliki Nicolaides, "Rethinking Informal and Incidental Learning in Terms of Complexity and the Social Context," *Journal of Adult Learning, Knowledge and Innovation* 1.1 (2017): 27-34.

[26] *The Handbook of Transformative Learning: Theory, Research, and Practice,* ed. Edward W. Taylor and Patricia Cranton (San Francisco, CA: Jossey-Bass, 2012).

[27] Henriette Lundgren, Rob F. Poell, "On Critical Reflection: A Review of Mezirow's Theory and Its Operationalisation," *Human Resource Development Review,* 15.1 (2016): 3-28.

cybernetic conduct is enacted, performed, or produced beyond the dualisms between the human mind and artificial intelligence, computer and human, mind and data.[28] Hence post-humanist theories of computational thinking assume a socio-technological viewpoint in which agency is distributed between humans and non-humans and in which the entanglement between the social world, virtual routines and virtual materiality can be subjected to inquiry. Our intention is to show that a renewed theory of knowledge-in-practice, the fruit of the "posthumanist turn" in computational studies, contributes to a re-reading of the relation between knowing, doing and change as situated in technological practices.

In this sense, this work includes:

1) the explanation of the conceptual perspectives and theoretical frameworks that underlie our insights;

2) a discussion of the technological context, the transformational axes on which we are asked to work as adult educators, our approach in dealing with the requests;

3) reflections on the methods to adopt, and on the impact of those conceptual achievements in our pedagogical praxis as adult educators and as scholars.

[28] Silvia Gherardi and Manuela Perrotta, "Doing by Inventing the Way of Doing: Formativeness as the Linkage of Meaning and Matter," *How Matter Matters: Objects, Artifacts and Materiality in Organisation Studies*, ed. Paul R. Carlile, Davide Nicolini, Ann Langley and Haridimos Tsoukas (Oxford: Oxford University Press, 2013) 227-59.